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Skin Problems among Users of the Urine-Based Fertiliser in Ouagadougou Periurban Areas, Burkina Faso: A Prospective Study

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Abstract

The great challenge for the sustainable use of excreta (urine, faeces) in agriculture is to increase the benefits of these products as resources and decrease the negative effects on human health. The risk of gastrointestinal diseases associated with the use of human excreta as natural fertilisers is well established, while information on skin problems remains largely anecdotal. The objective of this study was to evaluate the prevalence of skin problems among people involved in the handling of the urine used as fertiliser along a productive sanitation system in Ouagadougou periurban areas. A questionnaire was used for each targeted worker to collect data on sociodemographic characteristics, conditions of work and reported health symptoms such as skin burning, itching, eye irritation and paronychia. The exposure measurements were essentially based on field observations. A total of 435 people were interviewed, including 45 workers in urine storage sites, 209 farmers using urine-based fertiliser and 181 control farmers. More than 35% of site workers reported skin symptoms. For farmers using urine-based fertiliser and their controls, 17.2% and 26.0% reported skin symptoms, respectively. Overall, the associations between skin symptoms and the handling of urine used as fertiliser were almost significant ($P < 0.06$). Also, the study showed that these skin symptoms reported by the urine handlers are associated with conditions

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of work. Effective preventive measures such as wearing suitable protective equipment and practicing good personal hygiene should be emphasized. This topic needs to be further examined using longitudinal studies.

Keywords

Human Urine, Fertiliser, Exposure, Hazardous Agents, Skin Problems

1. Introduction

In order to decrease reliance on chemical fertilisers, human excreta (urine, faeces) are used in agriculture around the world [1]-[3]. In Burkina Faso, urine-based fertiliser was used firstly by truck farmers in Ouagadougou periurban areas, along productive sanitation systems [4]. The main steps in the management of a sanitation system are: urine collection from the eco-toilets (Urine Diversion Dry Toilet), transportation and storage (on a site) before the use as liquid fertiliser. The quality of the urine from these systems was previously evaluated [3] [4].

Human health risks associated with the use of wastewater and excreta in agriculture have been well shown [5]. Although the risk for certain gastrointestinal diseases has been established, the information on other potential human health risks is still largely anecdotal. Studies in many countries with farmers using wastewater suggested a high prevalence of the skin ailments [6]-[8]. In general, causes of these skin problems remained unknown [8] [9].

Also, farmers and workers involved in handling activities (e.g. cleaners) often complain about skin problems caused by various irritants and allergens, including sun [10], biological agents such as bacteria [11] [12] and chemicals such as pesticides and heavy metals [13]-[15]. Some soaps and detergents can damage the skin [16] [17].

The skin is a considerable interface between man and his environment [18]; it is an important portal of entry for hazardous agents and a vulnerable target tissue as well [19] [20]. Colonized by a normal resident flora, the skin is frequently contaminated by pathogens. Staphylococci and enterococci are the most common skin bacterial contaminants [12] [21] [22]. About 20% of the normal population carries continuously *Staphylococcus aureus* on the body. This chronic carriage is a risk factor for skin infections [23] [24]. Paronychia a skin infection of the fingers, occurs especially among manual workers. Staphylococci are the main causative agents, but can also be an Enterococcus or gram-negative bacteria [21].

In Burkina Faso, the incidence of skin diseases associated with exposure to wastewater and agricultural inputs (fertilisers and pesticides) is not known. This incidence is probably high for the following reasons: 1) The presence in irrigated water of some hazardous agents [25]-[27]; 2) The large amounts of chemical inputs frequently handled by farmworkers; 3) The use of prohibited pesticides in the agricultural sector [27]; and 4) The non-compliance with protective measures on handling some products in the fields [28].

Ammonia is used to produce chemical fertilisers. It also helps to preserve stored fruits [29]. However, this gas can cause severe skin irritation or burns due to its high solubility in water. Therefore, skin irritation can occur after sweating if the skin is in contact with ammonia, because of ammonia's caustic effect [29] [30]. Irritation due to ammonia can also affect eyes, causing watering and conjunctival ulceration. Glaucoma can occur after a long-term exposure to ammonia [29] [31].

This study was conducted among handlers of the urine used as fertiliser in Ouagadougou periurban areas, Burkina Faso. The main objective was to evaluate the prevalence of skin problems reported by people involved in the urine handling along a productive sanitation system.

2. Materials and Methods

2.1. Research Setting

The study was conducted in Ouagadougou periurban areas, where a large scale project in productive sanitation was implemented. For a period of three years (2006-2009), the project has equipped around 1000 households with eco-toilets (Urine Diversion Dry Toilets, UDDT). In each sector covered by the project, a productive sani-

tation system was set up, in which excreta is collected separately via UDDT and are transported and stored on a site before the use as fertilisers in the field. Urine was stored in jerry cans (20 L) and tanks (1000 L).

Each filled container was closed for at least 30 days. On average, 600 jerry cans and 15 tanks per site were used to manage the urine stocks. Our study was limited to two sites and conducted for a period of 11 months (February 2011-January 2012). Parameters of interest (pH, ammonia, heavy metals, *E. coli*, *S. aureus*, *Enterococcus sp*.) in urine from the studied sanitation system have been previously measured [3].

2.2. Study Population

Two groups of workers along productive sanitation systems were targeted: 1) Handlers of the urine in storage sites, in which the main tasks were collection and transportation of the urine from households to storage sites, and the decanting, cleaning and maintenance of containers; and 2) Farmers using urine-based fertiliser. A control group was integrated in this study, including non-urine using farmers, working in the same conditions as the others. All participants in this study were volunteers.

2.3. Data Collection

The survey on skin problems among targeted groups was preceded by the field visits in order to report the work conditions of people. To do this, forms were filled out at each visit, indicating observations concerning the hygiene practices in urine storage sites, the quality of irrigation water, and the protective measures taken during the urine handling. Data from field visits guided us to formulate relevant items for a questionnaire, which were individually administered at the workplace. The interviews were conducted face-to-face with investigators. The questionnaire was comprised of three parts: 1) The first part consists of items to collect sociodemographic characteristics of respondents; 2) The second part includes items relating to the environment and work conditions. These are the questions to find out what activities the person did, frequency of the urine handling, and about protective equipment used when working; and 3) The third part, which includes items relating to recent and/or current skin problems self-reported for the duration of work. Skin burning, itching, eye irritation and paronychia were the health symptoms examined. The location of these symptoms was also required to respondents.

2.4. Data Analysis

Statistical analysis of data was performed using the STATA V12.1 (Stata Corp 4905 Lakeway Drive, Texas, USA) software. The variables were analyzed by Chi-square test or Fisher's exact test. A *P*-value less than 0.05 was considered statistically significant.

3. Results

3.1. Description of the Study Population

In total, 435 people responded to the questionnaire, including forty-five (45) site urine handlers, two hundred and nine (209) farmers using urine-based fertiliser and one hundred eighty-one (181) as control farmers. The sociodemographic characteristics of the respondents are presented in **Table 1**.

The average age of respondents was about 38 years. Male interviews predominated, with 60% and 80% for site workers and farmers respectively. The majority of those interviewed people had a low level of education (primary or uneducated). Among field workers, truck farmers were the most numerous (97%), followed by flower growers (3%). For the duration of work, 53% of site urine handlers had more than 3 years and 20% had one year or less. About 87% of farmers had more than 3 years in working.

3.2. Skin Problems among Targeted Groups

More than 35% of site urine handlers have reported skin symptoms (**Table 2**), including skin burning (8.8%), itching (22.2%) and eye irritation (4.4%). No case of paronychia has been reported. Overall, the association between reported skin symptoms and the handling of urine on storage site was significant ($P < 0.05$).

In farmers, handling and non handling (control) the urine, the percentage of reported skin symptoms were 17.2% and 26.0% respectively (**Table 2**). These health symptoms reported by farmers handling the urine and their controls included, skin burning (4.8% vs. 7.7%), itching (6.7% vs. 4.4%) and paronychia (5.7% vs. 13.8%).

Table 1. Main sociodemographic characteristics of all respondents.

Personal characteristics	Site urine handlers n = 45	Urine handling farmers n = 209	Control farmers n = 181
Age (year)			
Mean[δ] (SD)	37.1 (12.6)	39.9 (9.0)	38.6 (11.9)
Age groups			
<21 n (%)	5 (11.1)	7 (3.3)	22 (12.1)
21 - 49 n (%)	30 (66.6)	163 (77.9)	115 (63.5)
>49 n (%)	10 (22.2)	39 (18.6)	44 (24.3)
Sex			
Male n (%)	27 (60)	193 (92.3)	127 (70.1)
Female n (%)	18 (40)	16 (7.6)	54 (29.8)
Educational level			
High school n (%)	0 (0)	1 (0.5)	0 (0)
Secondary school n (%)	10 (22.2)	25 (11.9)	17 (9.4)
Primary school n (%)	20 (44.4)	73 (34.9)	29 (16.0)
Uneducated n (%)	15 (33.3)	110 (52.6)	135 (74.5)
Farming type			
Horticultural n (%)	/	206 (98.5)	173 (95.5)
Ornamental n (%)	/	3 (1.4)	8 (4.5)
Duration of work (year)			
<1 n (%)	9 (20)	6 (2.8)	6 (3.3)
1 - 3 n (%)	12 (26.6)	11 (5.3)	25 (13.8)
>3 n (%)	24 (53.3)	192 (91.8)	150 (82.8)

[δ]Values given as mean (SD).

Table 2. Percentage of skin problems reported by respondents.

Symptoms	Site urine handlers n = 45	Urine handling farmers n = 209	Control farmers n = 181
	n (%)	n (%)	n (%)
Overall	16 (35.5)	36 (17.2)	47 (26.0)
Burning	4 (8.8)	10 (4.8)	14 (7.7)
Itching	10 (22.2)	14 (6.7)	8 (4.4)
Paronychia	0 (0)	12 (5.7)	25 (13.8)
Eye irritation	2 (4.4)	0 (0)	0 (0)

3.3. Occurrence of Skin Symptoms and Work Conditions

In **Table 3**, it is shown the incidence rates of skin symptoms related to work conditions in handlers of the urine on storage site. Sixteen (16) workers (n = 45) reported skin problems “due to the urine exposure”. In less than one year in working, 50% and 30% of them respectively had complained about skin burning and itching. Those who reported eye irritation had more than 3 years in the work.

Table 3. Incidence rate of skin symptoms reported by site urine handlers.

Variables	Skin burning	Itching	Eye irritation
	%	%	%
Duration of work (year)[†]			
<1	50	30	0
1 - 3	25	40	0
>3	25	30	100
Frequency in urine handling[†]			
≥Twice per week	75	60	100
≤Twice per week	25	40	0
Personal protective equipment			
Yes	100	90	100
No	0	10	0
Location of skin symptoms			
Hand	37.5	25	0
Forearm	37.5	50	0
Foot	25	0	0
Other	0	25	100

[†]$P = 0.06$.

By handling the urine on storage site, with a frequency of more than twice per week, had given incidence rates of 75%, 60% and 100% respectively for skin burning, itching and eye irritation (**Table 3**). Surprisingly, we observed that almost all workers on the urine storage site and who reported skin symptoms had personal protective equipment consisting of a coat with short sleeves, a gas mask, boots and gloves. This data confirms the observations made in the field in that there was a lack of interest in wearing this protective equipment, the poor state and the unsuitability of these protective materials. Skin symptoms mentioned were reported more than once in the concerned site workers. Itching and skin burning were most often located on forearms, hands and feet.

In **Table 4**, the incidence rates of skin symptoms reported by farmers using urine-based fertiliser are presented.

In farmers handling urine-based fertiliser which reported skin symptoms (26 among 209 in total), about 85% had at least two years in the work. For these farmers, the frequency of handling urine averaged once per week. More than half of farmers (59%) did not use a personal protective equipment (**Table 4**). Skin burning and itching were experienced by all reporting farmers (100%). For paronychia, 83.3% of reporting people were truck farmers and 16.7%, flower growers. Overall, the skin burning was most often located on hands and feet, while itching occurred on forearms. Except for paronychia, the other skin symptoms were experienced more than once by almost all reporting farmers. Observations in the field have shown that the farmers' existing protective equipment was not worn automatically during the urine handling. The reasons for this disinterest on wearing personal protective equipment have not been clearly given. Also, in the opinion of almost all farmworkers interviewed, "the quality of the water used for irrigation was good, since it was extracted from wells and dams". Taking into account all of these skin symptoms that were reported, the associations found between work factors, particularly the frequency of the urine handling and the duration of work (**Table 3** and **Table 4**) were almost significant ($P = 0.06$).

4. Discussion

In this study, we evaluated the possible links between skin problems and the handling of urine among people

Table 4. Incidence rate of skin symptoms reported by farmers using urine-based fertilizer.

Variables	Skin burning	Itching	Paronychia
	%	%	%
Duration of work (year)[†]			
<1	10	0	8.3
1 - 3	30	40	25
>3	60	60	66.7
Frequency in urine handling[†]			
≥Twice per week	0	0	0
≤Twice per week	100	100	100
Personal protective equipment			
Yes	50	29	41.7
No	50	71	58.3
Farming type			
Horticultural	100	100	83.3
Ornamental	0	0	16.7
Location of skin symptoms			
Hand	36.3	35.7	100
Forearm	27.2	50	0
Foot	36.3	14.3	0
Other	0	0	0

[†]$P = 0.06$.

involved within productive sanitation systems in Ouagadougou periurban areas. The health symptoms examined were essentially skin burning, itching, eye irritation and paronychia, which can be caused by various agents potentially existing in the work environment. Exposure measurements were based mainly on observations made at any moment by the urine handlers on the workplace (storage site and farm field). We also considered as indicators of risk, data from a previous study on the characterization of chemical (pH, ammonia, heavy metals) and bacteriological (*E. coli*, *S. aureus*, *Enterococcus sp.*) parameters in the urine of the studied sanitation system [3].

Overall, the results of this study indicate skin symptoms reported by respondents were associated with the work they do. The prevalence of skin problems in the urine site urine handlers was almost the double of that found in farmers handling urine-based fertiliser (**Table 2**). Yet, according to field observations, the wearing of the personal protective equipment while handling urine was spontaneous among site workers compared to farmers. The handling of the untreated urine (before storage) may have more risk of disease transmission [32]. Based on this assumption, the high prevalence of skin symptoms in handlers of urine on storage sites (compared to farmers) was uncovered. Wearing personal protective equipment did not effectively prevent skin symptoms. This data confirms the observations made at the field regarding protective materials (poor state and unsuitable).

We observed that farmers not handling urine-based fertiliser also reported skin symptoms. Further investigations on the risks faced by farmers in the fields are needed. It is likely that the causes of skin diseases among farmworkers are many. However, some studies suggested that exposure to chemical inputs, e.g. pesticides and fertilisers [14] [33] and irrigation water [8] [34] were the main causes of skin problems self-reported among farmers. Wastewater often used in urban agriculture potentially contains chemical (e.g. heavy metals, pesticide residues) and biological agents (e.g. bacteria, viruses, enzymes) which, in contact with skin can affect it. Farmers interviewed in this study extracted their irrigation water from wells and dams. Regular skin contact with

water can have a risk of disease because this irrigated water probably contains chemical and biological contaminants from soil or various releases [25] [27] [35]. However, the wearing of personal protective equipment during the handling of chemical inputs and wastewater could minimize the risk of some skin symptoms.

In addition, we observed significant associations between examined skin symptoms and work conditions, particularly the frequency of the urine handling and the duration of work (**Table 3** and **Table 4**). Our field observations showed that all urine handlers complained of strong smells due to ammonia, while the so-called "gas mask" was worn. We also found that there could be phases in the urine handling that are more at risk than others. For example among site urine handlers, exposure risks are high by transporting and decanting urine. In farm, workers using urine-based fertiliser, mix preparation (dilution) are probably the crucial exposure phase. During these all activities, parts of the body not covered such as face, hands and forearms were in frequent contact with aerosols from urine.

Previous studies have shown that the handling of products with high alkalinity (pH > 12), exposed people to the risk of skin burning [30] [36]. However, pH values of the handled urine by targeted actors were less than 9 [3]; therefore, the alkaline effect of urine on the skin of handlers is probably negligible. Also, the concentrations of chromium, lead, copper, cadmium and nickel in the urine were low [3]. So, the implication of heavy metals effects explaining the skin symptoms experienced by the urine handlers can be excluded, as much as the affected body parts (hands, forearms, eyes) were not directly "dipped" in urine during the handling. Moreover, skin irritation due to ammonia can be considered, because of its high concentration in the handled urine and its possible caustic effect on a sweated skin. Based on the above data, it seems clear that the hot and semi-arid climate favoring excessive sweating can be a worsening factor of ammonia toxicity, that also was confirmed by authors [30].

Other associations found in this study are difficult to explain. This is the case of the connection between the occurrence of a paronychia and exposure to the urine-based fertiliser, in the sense that the causative agent is often carried by the subject himself [12] [21]. In this situation, it is necessary that good hygiene practices, including washing the body after work be maintained to prevent some skin diseases.

Few limits to this study can be mentioned. First, respondents were asked to recall the experienced skin symptoms, since the beginning of their work. It is possible that subjective responses have been provided by the surveyed population. In order to minimize these errors due to oversight, Vallejos and *et al.* [14] asked to farmworkers handling pesticides to recall their skin symptoms reported in the previous seven days before the interview. But, we think that approach to be too limiting the period for recalling health symptoms, potentially hiding some evidence related to exposures. Second, skin problems examined in this study may result from many causes and cannot be solely attributed to the urine exposure. As proof, farmers not handling urine-based fertiliser reported the same skin symptoms that handlers. Third, the method of data collection used do not reflect precise measurements as the severity and the duration of the reported skin symptoms, which are important parameters for assessing effects associated with exposure to hazardous substances. In order to lessen the mentioned limits, we think that conducting longitudinal studies could be necessary, because they analyze in long-term targeted groups. Unfortunately, in the context of the current study, it was difficult to constitute cohorts among the urine handlers since their work was unstable and precarious.

Having a better understanding of factors associated with the occurrence of skin problems can help in efforts to prevent and to treat [14] [37]. Thus, one of the strengths of this study was to provide information on the prevalence of skin symptoms in people exposed to the urine used as fertiliser. The results of this first investigation may call out the people exposed to products possessing a potential health risk (e.g. chemical inputs, excreta-based fertilisers) to reinforce personal protective measures. Wearing a suitable protective equipment including coat with long sleeves, gloves covering forearms, boots and goggles, should certainly reduce the risk of skin symptoms here investigated.

5. Conclusion

This study suggests the existence of associations between health symptoms such as skin burning, itching, eye irritation and the handling of the urine used as fertiliser. The harmful effect of ammonia on the skin seems predominant compared to other measurable parameters in the handled urine. However, skin symptoms examined in this study could not be exclusively attributed to the urine exposure; other factors inherent to the workplace can be implicated. Based on the data obtained, it is necessary that people involved in the handling of the urine used as fertiliser, have to maintain personal good hygiene practices and wear protective equipment while working to

reduce the health risks. In order to make our data more incisive and better explore the topic, additional studies are needed. For example, longitudinal studies by monitoring regularly some parameters (e.g. diagnosis, severity and duration of health symptoms) within cohorts, should better assess the effects of ailments due to some exposure. Thus, data from such studies can guide health policy makers, especially in the agricultural sector where the effects associated with exposure to chemical inputs are not well established.

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